

nerve-trunks, the comparison of sensory overlapping with motor overlapping, the relation of overlapping to acuteness of sensation; individual variation, its extent and frequency, as far as can be judged from the skin-fields. Comparison between the human brachial plexus and that of *Macacus* is made, and it is pointed out that the human plexus is slightly prefixed, as compared with that of *Macacus*.

Finally, in Section IV, "shock," and various spinal reactions are examined, especially with reference to their effects upon the size and other features of the areas of the root-fields, &c., and the results collated and discussed.

"Cataleptoid Reflexes in the Monkey." By C. S. SHERRINGTON, M.A., M.D., F.R.S., Holt Professor of Physiology, University College, Liverpool. Received December 29, 1896,—Read January 21, 1897.

A phenomenon came under my observation in the course of experiments upon monkeys at the commencement of the present year which seems sufficiently interesting to merit record here. Its occurrence, so long as certain conditions of experiment are maintained, appears regular and predictable.

Although the character of the movements executed by the skeletal muscles when excited reflexly through the medium of the isolated spinal cord is variable, one feature common to them is their comparative brevity of duration. Many of them are, as pointed out by Fick and by Wundt years ago, hardly distinguishable in several particulars from the simple twitches elicitable from an excised muscle, so brief and local and inco-ordinate do they appear to be. Others are more prolonged, and, as I have described in a paper recently communicated to the Society, exhibit various forms of sequence or "march" (Hughlings Jackson). Without recapitulating the conclusions there drawn from the data given in that paper, I wish here to merely point out that of movements due to purely spinal reflex action, although some are fairly extensive, most are quite short-lasting, and not so prolonged as the longer of those that can be elicited under appropriate conditions from the cortex cerebri; also that if prolonged they, like the final phase of prolonged movements initiated from the cortex, tend to become clonic, or to exhibit that kind of action which in the paper referred to above I have designated "alternating."

The reflex movements, the subject proper of this note, are, on the contrary, of extremely prolonged duration, and absolutely devoid of clonic character and of alternating character. If the cerebral hemi-

spheres be carefully removed, *e.g.*, from a monkey, with avoidance of hæmorrhage and of fall of body temperature, and if sufficient time be allowed to elapse for subsidence in the animal of what may be called immediate shock, movements can be evoked remarkably different from those I have ever seen elicitable as purely spinal or as cerebral reactions. If a finger of one of the monkey's hands be stimulated, for instance, by dipping it into a cup of hot water, there results an extensive reflex reaction involving movement of the whole upper limb. The wrist is extended, the elbow flexed, the shoulder protracted, the upper arm being drawn forward and somewhat across the chest. The movement occurs after a variable and usually prolonged period of latent excitation. The movement, although it may be fairly rapid, strikes the observer each time as perfectly deliberate; it is of curiously steady and "smooth" performance. Sometimes it is carried out quite slowly, and then, as a rule, the extent of it is less ample. The most striking feature of the reflex is, however, that when the actual movement has been accomplished *the contraction of the muscles employed in it does not cease or become superseded by the action of another group, but is continued even for ten and twenty minutes at a time.* The new attitude assumed by the limb is maintained, and that too without clonus or even tremor. In the instance cited, namely, that of the fore limb, the posture assumed suggests the taking of a forward step in quadrupedal progression, and in that posture the animal will remain for a quarter of an hour at a time.

The degree of, for instance, flexion assumed in the new posture seems much dependent on the intensity and duration of the stimulus applied. If the degree is extreme, the attitude of the limb may not be maintained to its full extent for the time mentioned; thus, the elbow, at first fully flexed, will in the course of a minute or so be found to have opened somewhat. This opening can be often seen to occur *per saltum*, as it were, but the steps are quite small, and recurrent at unequal intervals of between perhaps a quarter of a minute and a minute. After some relaxation from the extreme phase of the posture has taken place, the less pronounced attitude, *e.g.*, semiflexion at the elbow, may persist without alteration obvious to inspection for ten minutes or more. Apart from the occasional step-like relaxations, the contraction of the muscles is so steady as to give an even line when registered by the myograph. A renewed stimulation of the finger excites further flexion, which is maintained as before in the way above described. The posture can be set aside without difficulty by taking hold of the limb and unbending it; the resistance felt in the process of so doing is slight; the posture thus broken down is not reassumed when the limb is then released.

Analogous results are obtainable on the hind limb. Hot water

applied to a toe evokes always, so far as I have seen, flexion of ankle and knee; usually of hip also. This movement is "deliberately" executed, and always institutes a maintained posture.

If finger (or toe) of both right and left limb be placed together in the hot water, there results symmetrical reflex movement of both the right and the left fore limbs (or hind limbs), leading to assumption of a fairly symmetrical posture by the right and left limbs respectively, the posture being similar to but duplicate of that evoked in the one limb only on excitation of that limb. This may appear a self-evident sequel to the observation given earlier, but is not so when an observation immediately to be mentioned is taken into consideration.

Not the least interesting part of the reflexes under consideration is a remarkable glimpse which they allow into the scope of reflex inhibition as regards the co-ordinate of movements of the limbs. Although the posture taken up by the right fore limb consequent upon excitation of a finger is symmetrically duplicated by the left limb when both hands are simultaneously stimulated, the effect of excitation of the two hands does not lead to symmetrical posture if the excitation be not synchronous but successive. If when the right arm has already assumed its posture in response to an excitation of the right hand, the left hand be stimulated, there results, while the left arm in obedience to the excitation is lifted and placed in the flexed posture, an immediate and, if the stimulus be at all more than slight, complete relaxation of the right arm. The right arm drops flaccid while the left is raised and maintained in the raised attitude. Similarly, excitation of the right foot breaks down the posture assumed by the right arm, and conversely, and even more easily, stimulation of the right hand breaks down a posture assumed by the right leg. Again, a nip of the right pinna causes relinquishment of a posture assumed by the right arm or by the right leg. If the right pinna is pinched when both arms are in this cataleptoid posture, complete inhibition can be readily exerted on the right arm, but usually only partial relinquishment can be induced in the left arm. To exert complete inhibition upon the posture of the left arm, the pinna pinched must be that of the left side. Similarly the posture reflexly evoked by appropriate stimulation of either hind limb can be inhibited by excitation of either pinna or of either fore limb, but predominantly by pinna and fore limb of the same side as the limb to be inhibited. The inhibition of the hind limb is much more easily elicited from the opposite hind limb than from the opposite fore limb or opposite ear. I have never yet seen it obtained diagonally upon the fore limb from the opposite hind limb.

The movements obtained in the limbs by exciting the limbs themselves are only cited above as examples to illustrate the general

characters of the condition. The details of the results will be given in a fuller paper dealing with the subject. I was prevented from inquiring thoroughly into the phenomenon when it was first met with; but in the course of the present summer and autumn the investigation has been systematically undertaken. I will conclude this preliminary note by adding that throughout the observations the animal's respiration remains apparently unaffected by the stimuli effective to produce the various reflexes and inhibitions such as above described. The respiration is tranquil, rather deep, regular, and often somewhat frequent. The animal in all my experiments has been completely blind, but a sharp conjunctival reflex exists. The knee jerks are elicitable but are not exaggerated. The tonus of the sphincters appears about normal. The pulse is full, regular, and fairly frequent.

I have not at present succeeded in evoking the cataleptoid reflex by simply placing the limb in the desired posture.

In applying the term cataleptoid to these reflexes, I do so because the reflexes recall, in some respects, strikingly certain phases of hypnotic condition, by some writers distinguished as cataleptic, and because the strict significance of the prefix implies a steady maintenance of possession subsequent to seizure, and is therefore peculiarly applicable here, whether these reflexes be or be not allied to hypnotic catalepsy.

“On Reciprocal Innervation of Antagonistic Muscles. Third Note.” By C. S. SHERRINGTON, M.A., M.D., F.R.S., Holt Professor of Physiology, University College, Liverpool. Received December 29, 1896,—Read January 21, 1897.

In a former number* of these ‘Proceedings’ attention was drawn to a particular form of correlation existing between the activity of antagonistic muscles. In it, one muscle of an antagonistic couple is, it was shown, relaxed in accompaniment with active contraction of its mechanical opponent. The instance then cited was afforded by certain of the extrinsic muscles of the eyeball, but I had previously noted indications of a like arrangement in studying the reflex actions affecting the muscles at the ankle-joint of the frog,† and it seemed¹ probable that the kind of co-operative co-ordination demonstrated for the ocular muscles might be of extended application and occurrent in various motile regions of the body. The observations to be mentioned below do actually extend this kind of reciprocal innervation

* Vol. 52. April, 1893. Sherrington.

† Foster's ‘Journ. of Physiol.’ vol. 13, 1892.